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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/621,696	07/16/2003	Huey-Chiang Liou	42P15032	1504
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Michael A. Bernadicou BLAKELY, SOKOLOFF, TAYLOR, ZAFMAN LLP Seventh Floor 12400 Wilshire Boulevard Los Angeles, CA 90025			EXAMINER MAGEE, THOMAS J	
			ART UNIT 2811	PAPER NUMBER

DATE MAILED: 09/09/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/621,696

Applicant(s)

LIOU, HUEY-CHIANG

Examiner

Thomas J. Magee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 17 June 2004.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-20, and 22-28 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-12, 22, 23 and 25-28 is/are rejected.
- 7) ☒ Claim(s) 13 - 20, and 24 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## **DETAILED ACTION**

### ***Claim Cancellations***

1. Applicant's cancellation of Claim 21 in Letter of June 17, 2004 is acknowledged.

### ***Claim Rejections – 35 U.S.C. 112***

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 1 and 2 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In Claim 1 the phrase "sacrificial dielectric layer" is recited to isolate two conductive vertical series in forming a multilayer interconnect, whereas in dependent Claim 2, the presence of a "first layer of sacrificial dielectric material" and a "second layer of sacrificial dielectric material" is recited, along with "sacrificial dielectric material isolating conductive layers" and "sacrificial dielectric material isolating two additional conductive layers." It is unclear whether all of these are separate dielectric material layers or the same dielectric material layers. Correction and clarification is required.

For purposes of examination, it will be assumed that these are separate layers.

### ***Claim Rejections – 35 U.S.C. 102***

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1 – 12, 22, 23, and 25 - 28 are rejected under 35 U.S.C. 102(b) as being anticipated by Grill et al. (US 6,413,852 B1).

4. Regarding Claim 1, Grill et al. disclose a method of forming an air gap interconnect structure comprising:

forming a multilayer interconnect (Figures 1M, 1I) adjacent to a substrate layer (100) (Figure 1A) comprising conductive layers (185) positioned in two conductive vertical series, the conductive vertical series isolated from each other by sacrificial dielectric material (220') (Figure 1L),

forming a a (dielectric) protective layer (250) (Figure 1M) adjacent the interconnect, patterning the protective layer to expose portions of the sacrificial dielectric material (Figure 1M) (Col.7, lines 17 – 23),

decomposing portions of the sacrificial dielectric material to form a sacrificial dielectric decomposition product (Col. 7, lines 37 – 47), and

removing portions of the sacrificial dielectric decomposition product to form air gaps between the conductive layers (Figure 1N).

5. Regarding Claim 2, Grill et al. disclose the formation of a multi-layer interconnect, comprising:

forming a first layer (110, 120, 140) of sacrificial dielectric material, forming trenches (Figure 1C) (150,160) in the first layer, and filling the trenches with conductive material (185) (Figure 1E) isolated from each other by first sacrificial dielectric layer material, 220 (Figure 1H), and

forming a second layer of sacrificial dielectric material (110', 120', 140') (Figure 1J) adjacent the at least two conductive layers (185) and first sacrificial dielectric layer (220), wherein trenches are formed in the second layer and filled with conductive material (185') (Figure 1L) to form at least two additional layers isolated from each other by a sacrificial dielectric layer (220').

6. Regarding Claims 3 and 23, Grill et al. disclose the formation of two conductive layers in each conductive vertical series (Figure 1L).

7. Regarding Claims 4 and 5, Grill et al. disclose that decomposing comprises removing substantially all of the dielectric material between each (Figures 1N) of the vertical series at approximately the same time.

8. Regarding Claims 6 and 7, Grill et al. do not explicitly disclose that hydrofluoric acid and water are used to decompose or remove dielectric material, however, Grill et al. do disclose

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that etchback may include wet etching (Col. 5, lines 64 – 67). Since the dielectric layers include silicon dioxide (Col. 4, lines 63 – 67), it is inherent that an etchant such as HF and water would be used in removal.

9. Regarding Claim 8, Grill et al. disclose that the removal of dielectric layers comprises introducing a carrier plasma (Col. 5, lines 64 – 66).

10. Regarding Claim 9, Grill et al. disclose that the conductive layers are formed of copper (Col. 5, lines 41 – 43).

11. Regarding Claim 10, Grill et al. disclose that the sacrificial dielectric material is composed of silicon dioxide (Col. 4, lines 63 – 67).

12. Regarding Claim 11, Grill et al. disclose that the protective layer is silicon carbide (Col. 7, lines 32 – 36).

13. Regarding Claim 12, Grill et al. disclose the presence of vertical support structures (Col. 7, lines 26 – 28) (near holes) wherein removing portions of the sacrificial dielectric decomposition product further forms air gaps between the vertical support structures and the conductive vertical series.

14. Regarding Claim 22, Grill et al. disclose an air gap interconnect structure comprising:

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a substrate layer (100) (Figure 1A),

at least two conductive vertical series adjacent the substrate layer (Figure 1O), each conductive vertical series comprising a plurality of conductive layers, wherein the conductive vertical series are isolated from each other by air gaps (270') defined by the side walls of the conductive vertical series,

vertical support structures (Col. 7, lines 26 – 28) (near holes) wherein removing portions of the sacrificial dielectric decomposition product further forms air gaps between the vertical support structures and the conductive vertical series, and

a capping layer (280/250) adjacent to and above upper surfaces of the vertical support structures and the conductive vertical series.

15. Regarding Claim 25, Grill et al. disclose a contact structure (290) (Figure 1P) extending through the capping layer to contact an underlying conductive layer of a conductive vertical series.

16. Regarding Claim 26, Grill et al. disclose a method to form an air gap interconnect structure comprising:

positioning a first capping layer (280/250) (Figure 1O) adjacent to the surfaces of the conductive vertical series furthest from the substrate layer.

Grill et al. do not explicitly disclose deflecting ("pushing") the capping layer (280/250) toward the substrate layer. However, Grill et al. do disclose (Col. 8, lines 46 – 49) that

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additional dielectric layers are deposited atop the cap layer. Since these layers will create a level of stress wherein the cap layer would be deformed, it is then inherent that, after device fabrication, the cap layer will be deflected.

17. Regarding Claim 27, as discussed above, a tensile load can be applied in a direction substantially parallel to the substrate layer to the first capping layer while the capping layer is positioned by depositing a dielectric layer atop the cap layer.

18. Regarding Claim 28, Grill et al. disclose an air gap interconnect structure comprising:

a substrate layer (100) (Figure 1A),

a first conductive vertical series (left side) (Figure 3A) adjacent the substrate layer having a plurality of conductive layers, and having a first side wall and a second side wall, each side wall extending substantially perpendicularly from the substrate layer,

a second conductive vertical series (right side) (Figure 3A) adjacent the substrate layer having a plurality of conductive layers, and having a first side wall and a second side wall, each side wall extending substantially perpendicularly from the substrate layer,

layers of silicon nitride (210) (Col. 6, lines 38 – 41) on each of the first and second side walls of the first conductive vertical series and the first and second side walls of the second conductive vertical series, and

at least one peripheral vertical support structure, wherein no peripheral vertical support structure is between the first and second conductive vertical series (210, far right and far left hand sides, Figure 3A).



### ***Claim Objections***

19. Claims 13 – 20, and 24 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The prior art of record do not reasonably teach or suggest, either singularly or in combination, the limitation of *“a first capping layer to contact the vertical support structures and surfaces of the most highly positioned conductive layers within each conductive vertical series or the protective layer on each conductive vertical series,”* and an air gap interconnect structure *“wherein the vertical support structures peripheral to the conductive vertical series protrude slightly more from the plane of the substrate layer than the uppermost conductive layer.”*

### ***Response to Arguments***

20. Applicant's arguments with respect to claims have been carefully considered, but these have not been found to be persuasive. With regard to arguments (pp. 9 – 10, Response) on the “sacrificial dielectric material” layers, Examiner is unsure of the designations used by Applicant, and the claim language is indefinite, as discussed in the Office Action. Additional commentary at this point would be moot.

With regard to Grill et al. and the existence of an interconnect when the mask layer is formed, (p. 9, Response) Applicant is incorrect in the contention that the interconnect does not exist in Grill et al. when the mask layer is deposited. Mask layer 250 is formed (Figures 1L and 1M) after the formation of the multilayer interconnect and is adjacent the interconnect wherein, patterning of the layer exposes portions of the sacrificial dielectric layer, as recited in Claim 1.

Regarding Claim 4 (p. 10, Response), Applicant is arguing relative to the amended claim and not the original. However, Examiner has described in the Office Action that "both" layers are decomposed at the same time, as recited in the amended claim.

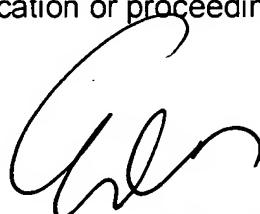
Regarding Claims 12 and 22 (p. 11, Response), Examiner has addressed in the Office Action, the limitations presented by Applicant in the amended claims. Grill et al. do disclose vertical support structures with air gaps between the support structures and conductive series.

Regarding Claim 11 (p.12, Response), commentary is moot since Examiner uses Grill et al. to read on the claim.

### **Conclusions**

21. Any inquiry concerning this communication or earlier communications from the

Examiner should be directed to **Thomas Magee**, whose telephone number is **(571) 272 1658**. The Examiner can normally be reached on Monday through Friday from 8:30AM to 5:00PM (EST). If attempts to reach the Examiner by telephone are unsuccessful, the examiner's supervisor, **Eddie Lee**, can be reached on **(571) 272-1732**. The fax number for the organization where this application or proceeding is assigned is **(703) 872-9306**.



**EDDIE LEE**  
**SUPERVISORY PATENT EXAMINER**  
**TECHNOLOGY CENTER 2800**

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Thomas Magee  
August 28, 2004